

Southeast Asian ticks (*Acari: Ixodida*): a historical perspective

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Abstract Our knowledge of the species of ticks present in Southeast Asia is good, particularly due to the vast amount of work from the 1960s to the 1980s by Hoogstraal and colleagues. Unfortunately, this knowledge is scattered throughout the specialist literature, and there is currently no synopsis available. In addition, our knowledge of the tick fauna of several countries, for example Cambodia, Laos, and Myanmar, is very limited.

History

The study of Southeast Asian ticks [Southeast Asia being defined to include Brunei, Cambodia, East Timor, Indonesia (excluding Irian Jaya), Laos, Malaysia, Myanmar, the Philippines, Singapore, Thailand, and Vietnam] can be roughly divided into three phases: (1) an early phase with scattered reports, usually of small collections sent to Europe for identification, (2) a phase dominated by Harry Hoogstraal and colleagues who discovered and systematically described a large number of new species, as well as redescribed and

unraveled many of the taxonomic problems involving those species already described, and (3) a phase, continuing until today, in which work on ticks has stagnated in most countries of the region except for a few regional reports and important collections. These three phases will be briefly discussed. It should be noted that a full review of the history of tick research in this region would be much longer than either time or space allows. Thus, we have not been able to mention many workers who have contributed significantly to this area. We hope, however, that we have been able to show the major currents in tick research in Southeast Asia and have provided a framework for understanding the present taxonomic situation for ticks in this region.

Phase 1

The first major period in the history of tick taxonomy occurred in the late 1800s and early 1900s. During this period, ticks were sent to a number of European specialists from many independent countries and colonies. This was also true for ticks from Southeast Asia, many new species of which were described by Neumann in Toulouse, France and Nuttall and Warburton in Cambridge, England. This work led to a number of general guides to tick genera which included Southeast Asian species: *Ixodes* (Nuttall and Warburton 1911), *Haemaphysalis* (Nuttall and Warburton 1915), *Amblyomma* (Robinson 1926) and the works of Neumann (e.g., 1899, 1901, 1911). Most of these were rapidly made obsolete by the discovery of new species and the synonymy of old species (see Camicas et al. 1998 for a general guide to tick synonymy). Although dated, the only one of these that is of real value today is that on *Amblyomma*, both for its keys to the adult stages and its fine illustrations.

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Report Documentation Page				Form Approved OMB No. 0704-0188	
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1. REPORT DATE 2007		2. REPORT TYPE		3. DATES COVERED 00-00-2007 to 00-00-2007	
4. TITLE AND SUBTITLE Southeast Asian ticks (Acari: Ixodida): a historical perspective				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Defense Pest Management Information Analysis Center (DPMIAC), Armed Forces Pest Management Board (AFPMB), Walter Reed Army Medical Center, Washington, DC, 20307-5001				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution unlimited					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT see report					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT Same as Report (SAR)	18. NUMBER OF PAGES 5	19a. NAME OF RESPONSIBLE PERSON
a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified			

Coming somewhat later than Neumann and Nuttall, the German Paul Schulze made important contributions to our knowledge of Southeast Asian ticks. He received small collections from Myanmar (Burma), Java, and other areas in Indonesia (Schulze 1930, 1933, 1934a, 1937, 1939). Among Schulze's achievements was the definition of the subgenus *Indocentor* of the genus *Dermacentor* (Schulze 1934b). Unfortunately, Schulze often used small morphological variations which lay within the normal range for a species to define new species, with the result that a number of the species from Southeast Asia which he described are now recognized as junior synonyms of previously recognized species. Somewhat later during this phase, several regional guides were published: Vietnam (Toumanoff 1944), Indonesia (Anastos 1950), the Philippines (Kohls 1950), and Malaysia (Kohls 1957). Unfortunately, much of this early work was done in isolation and relied on small samples. As a result, by the late 1950s, the taxonomy of Southeast Asian ticks had become confused.

Phase 2

After the Second World War, the USA took an interest in the potential vectors of human disease in Southeast Asia. This was partly responsible for the publications by Glen Kohls on the ticks of the Philippines (Kohls 1950) and Malaysia (Kohls 1957), in which a number of new species were described. However, the renaissance in tick research in the area was largely due to Harry Hoogstraal and his co-workers, including Carleton Clifford, Jim Keirans, Glen Kohls, Harold Trapido, and Hilda Wassef who were responsible for the description of a large number of new species, particularly in the genus *Haemaphysalis* (Hoogstraal and Kim 1985). In addition, and equally important, Hoogstraal's group succeeded in unraveling complex taxonomic problems in several species and genera. In this

context, the genus *Dermacentor* can serve as an example. Before the work of Hoogstraal and Wassef (1984, 1985a, b, 1988; Wassef and Hoogstraal 1983, 1984a, b, 1986a, b; Hoogstraal et al. 1986), *Dermacentor auratus* was a catch-all for the Southeast Asian species of this genus, and the status of the genus was highly confused (Wassef and Hoogstraal 1983, 1984a, b, 1986a). With a last, for Hoogstraal posthumous publication in 1988, Hoogstraal and Wassef had redescribed the males and females of the four species known to occur in Southeast Asia (*D. atrosignatus*, *D. auratus*, *D. compactus*, and *D. steini*), as well as *D. taiwanensis* from Taiwan and the southern islands of Japan (Hoogstraal et al. 1986; Wassef and Hoogstraal 1986a; *D. taiwanensis* has also recently been reported from Vietnam by Kolonin 1995). This work was detailed and systematic, based on a large number of collections and a multitude of ticks. The research of Hoogstraal and colleagues yielded many high-quality publications which described the distribution, hosts, and medical and veterinary significance of numerous Southeast Asian species. This work in general is the basis on which our knowledge of Southeast Asian ticks is today grounded.

Phase 3

With the death of Hoogstraal in 1986, large-scale systematic work largely ceased, and the number of publications on ticks from the area markedly declined. The only two major studies on regional tick faunas were made by Tanskul et al. (1983) for Thailand and Kolonin (1995) for Vietnam. A monograph on the ticks of Vietnam by Phan was also published in 1977 (Phan 1977). This described a variety of new species and provided information on the hosts and distributions of those already known. Unfortunately, this book is extremely rare and is written in Vietnamese so that its accuracy, and therefore value, is

Table 1 A list of the approximate number of tick species per genus found in Southeast Asia

Family	Genus/ subgenus	Number of species/ subspecies	Source
Argasidae	<i>Argas</i>	3	Petney 1993
	<i>Carios/</i>	4	Petney 1993
	<i>Ornithodoros</i>		
Ixodidae	<i>Amblyomma</i>	12	Petney 1993
	<i>Aponomma</i> ^a	9	Petney 1993
	<i>Boophilus</i> ^b	1	Petney and Keirans 1996
	<i>Dermacentor</i>	5	Petney and Keirans 1996
	<i>Haemaphysalis</i>	52	Petney and Keirans (unpublished data)
	<i>Hyalomma</i>	2–3	Petney and Keirans 1995; Kolonin 1995, 2003; Robbins et al. 2002
	<i>Ixodes</i>	14	Petney and Keirans 1994
	<i>Nosomma</i>	1	Petney and Keirans 1996
	<i>Rhipicephalus</i>	3	Petney and Keirans 1996

^a Considered to belong to the genus *Amblyomma* by some specialists (Klomp et al. 2002).

^b Considered to be a subgenus of *Rhipicephalus* by some specialists (Beati and Keirans 2001).

unclear. In the 1990s, Petney (1993) and Petney and Keirans (1994, 1995, 1996, 1997) summarized the known hosts, distributions, and medical and veterinary importance of the Southeast Asian species in the genera *Amblyomma*, *Aponomma*, *Boophilus*, *Dermacentor*, *Hyalomma*, *Ixodes*, *Nosomma*, and *Rhipicephalus*. Unfortunately, this series did not include the most species-rich genus *Haemaphysalis*, which has its center of diversity in this area, or the argasid species. Kolonin (1995) provided a comprehensive study of the ticks of Vietnam. In addition, there have been a number of significant collections which have extended the range of several species.

Some significant collections, predominantly from wild-life, have been reported (Robbins et al. 1997, 2002, 2004, 2006; Kollars and Sithiprasasna 2000; Robbins and Platt 2000; Kolonin 2003), and a few new species have been described (*Haemaphysalis grochovskajae*, Kolonin 1992 and *Haemaphysalis suntzovi*, Kolonin 1993) or redescribed (*Amblyomma babirussae*, Keirans and Robbins 1987).

Current status

About 104 species of ticks from 12 genera are found in Southeast Asia (Table 1). A few have been introduced, such as the dog parasite *R. sanguineus*, which is an important vector of canine diseases. The most species-rich genus is *Haemaphysalis*, with about 52 species (Table 1) or 31% of the world fauna; 23 of these belong to the subgenus *Kaiseriana*. In general, although a good deal is known about the species of ticks present in Southeast Asia, the only reasonably up-to-date national guides are those of Kolonin (1995) for Vietnam and the somewhat older publication for Thailand by Tanskul et al. (1983). The only major relatively up-to-date keys for identifying ticks to species level are those of Tanskul and Inlao (1989) for adult *Haemaphysalis* in Thailand and the keys to male and female stages, with line drawings of the basis capituli of nymphs and larvae of the three species of Southeast Asian *Rhipicephalus* (*R. haemaphysaloides*, *R. pilans*, and *R. sanguineus*) in Walker et al. (2000). Kaufman's (1972) major taxonomic revision of the difficult genus *Aponomma* (regarded by some acarologists as belonging to the genus *Amblyomma* except for the "indigenous Australian *Aponomma* group" which has been given the genus name *Bothriocroton*, Klompen et al. 2002) was never formally published in a journal or as a monograph but remains in thesis form. Most of the studies by Hoogstraal and colleagues are available in well-circulated journals; however, much early work and a good deal of that published more recently is to be found in specialist journals, often with low circulation and, in some cases, no longer published.

For Cambodia, Laos, and Myanmar, there is very little information available on the ticks present, and no national guide has ever been published.

Medical and veterinary significance

The presence of tick-borne pathogens in Southeast Asia has been recognized for many years (e.g., Smith 1956; Marchette 1966; see also Petney 1993). These include *Anaplasma*, *Babesia*, *Ehrlichia*, and *Rickettsia* (Chansiri et al. 1999; Suksawat et al. 2001; Tay et al. 2002; Hirunkanokpun et al. 2003; Parola et al. 2003). Over the last two decades, the number of new pathogens of potential veterinary (and human) importance discovered in ticks has increased markedly. In Asia, new species of *Babesia* (Luo et al. 2002), *Ehrlichia* (Wen et al. 2002), *Rickettsia* (Hirunkanokpun et al. 2003), and *Theileria* (Sarataphan et al. 1999; Chansiri and Sarataphan 2002) have been discovered. The medical and veterinary significance of these pathogens remains largely unknown. This lack of information on the epidemiology of tick-borne diseases in Southeast Asia is of great concern. In many cases, the most basic data on distribution, prevalence, and vector relationships are lacking, let alone information on the economic and human burden due to lost productivity. Anecdotal information from northeast Thailand suggests that attempts to introduce *Bos taurus* to enhance animal protein (meat and milk) production have been hampered by tick-borne diseases (Satrawaha, personal communication). Thus, this area of the world stands in stark contrast to much of Africa where a great deal of basic research on ticks and the diseases which they transmit was carried out more than 30 years ago (e.g., Decastro 1997). To implement successful tick and tick-borne disease control programs, basic data on the ecology and epidemiology of the ticks and the diseases which they transmit are sorely needed.

Acknowledgments Supported in part by the European Commission's Inco-Dev Coordinated Action "International Consortium on Ticks and Tick-borne Diseases" (ICTTD-3), Project number 510561.

References

- Anastos G (1950) The scutate ticks, or Ixodidae, of Indonesia. Entomol Am 30:1–144
- Beati L, Keirans JE (2001) Analysis of the systematic relationships among ticks of the genera *Rhipicephalus* and *Boophilus* (Acari: Ixodidae) based on mitochondrial 12S ribosomal DNA gene sequences and morphological characters. J Parasitol 87:32–48
- Camicas J-L, Hery J-E, Adam F, Morel PC (1998) The ticks of the world (Acarida, Ixodida). Nomenclature, described stages, hosts, distribution. Éditions de l'Orstom, Paris

- Chansiri K, Sarataphan N (2002) Molecular phylogenetic study of *Theileria* sp. (Thung Song) based on the thymidylate synthetase gene. *Parasitol Res* 88:S33–S35
- Chansiri K, Kawazu S, Kamio T, Tereda Y, Fujisaki K, Philippe H, Sarataphan N (1999) Molecular phylogenetic studies on *Theileria* parasites based on small subunit ribosomal RNA gene sequences. *Vet Parasitol* 83:99–105
- Decastro JJ (1997) Sustainable tick and tick-borne disease control in livestock improvement in developing countries. *Vet Parasitol* 71:77–97
- Hirunkanokpun S, Kittayapong P, Cornet JP, Gonzalez JP (2003) Molecular evidence for novel tick-associated spotted fever group rickettsiae from Thailand. *J Med Entomol* 40:230–237
- Hoogstraal H, Wassef H (1984) *Dermacentor (Indocentor) compactus* (Acari: Ixodoidea: Ixodidae): wild pigs and other hosts and distribution in Malaysia, Indonesia and Borneo. *J Med Entomol* 21:174–178
- Hoogstraal H, Kim KC (1985) Tick and mammal coevolution, with emphasis on *Haemaphysalis*. In: Kim KC (ed) *Coevolution of parasitic arthropods and mammals*. Wiley, New York, pp 505–568
- Hoogstraal H, Wassef H (1985a) *Dermacentor (Indocentor) auratus* (Acari: Ixodoidea: Ixodidae): hosts, distribution and medical importance in tropical Asia. *J Med Entomol* 22:170–177
- Hoogstraal H, Wassef H (1985b) *Dermacentor (Indocentor) atrosignatus* (Acari: Ixodoidea: Ixodidae): hosts and distribution in the Malay Peninsula, Indonesia, Borneo, and southern Philippines. *J Med Entomol* 22:644–647
- Hoogstraal H, Wassef H (1988) *Dermacentor (Indocentor) steini* (Acari: Ixodoidea: Ixodidae): hosts, distribution in the Malay Peninsula, Indonesia, Borneo, Thailand, the Philippines, and New Guinea. *J Med Entomol* 25:315–320
- Hoogstraal H, Wassef H, Santana FJ, Kuntz RE (1986) *Dermacentor (Indocentor) taiwanensis* (Acari: Ixodoidea: Ixodidae): hosts and distribution in Taiwan and southern Japan. *J Med Entomol* 23:286–288
- Kaufman TS (1972) A revision of the genus *Aponomma*, Neumann, 1899 (Acarina: Ixodidae). PhD dissertation, University of Maryland
- Keirans JH, Robbins RG (1987) *Amblyomma babirussae* Schulze (Acari: Ixodidae): redescription of the male, female, and nymph and description of the larva. *Proc Entomol Soc Wash* 89:646–659
- Klomp H, Dobson SJ, Barker SC (2002) A new subfamily, Bothriocrotoninae n. subfam., for the genus *Bothriocroton* Keirans, King and Sharrad, 1994 status amend. (Ixodida: Ixodidae), and the synonymy of *Aponomma* Neumann, 1899 with *Amblyomma* Koch, 1844. *Syst Parasitol* 53:101–107
- Kohls GM (1950) Ticks (Ixodoidea) of the Philippines. *Nat Inst Health Bull* 192:1–28
- Kohls GM (1957) Malaysian parasites-XVIII Ticks (Ixodoidea) of Borneo and Malaya. *Stud Inst Med Res Malaya* 28:65–94
- Kollars TM Jr, Sithiprasasna R (2000) New host and distribution record of *Amblyomma javanense* (Acari: Ixodidae) in Thailand. *J Med Entomol* 37:640
- Kolonin GV (1992) Tick fauna (Acarina: Ixodidae) of vertebrates of Vietnam (in Russian). In: Sokolov VE (ed) *Zoological Researches Vietnam*. Moscow, Nauka, pp 242–276
- Kolonin GV (1993) *Haemaphysalis suntzovi*, a new species of ixodid tick (Acari) from Vietnam. *J Med Entomol* 30:966–968
- Kolonin GV (1995) Review of the ixodid tick fauna (Acari: Ixodidae) of Vietnam. *J Med Entomol* 32:276–282
- Kolonin GV (2003) New data on ixodid tick fauna of Vietnam. *Entomol Rev* 83(Suppl 2):S190–S192
- Luo J, Yin H, Guan G, Zhang Q, Lu W (2002) Description of a new *Babesia* sp. infective for cattle in China. *Parasitol Res* 88:S13–S15
- Marchette NJ (1966) Rickettsioses (tick typhus, Q-fever, urban typhus) in Malaya. *J Med Entomol* 2:339–371
- Neumann G (1899) Révision de la famille des Ixodidés, 3^e Mémoire. *Mem Soc Zool France* 12:107–293
- Neumann G (1901) Révision de la famille des Ixodidés, 4^e Mémoire. *Mem Soc Zool France* 14:249–372
- Neumann G (1911) Ixodidae. In: *Das Tierreich*. R. Friedländer und Sohn, Berlin
- Nuttall GHF, Warburton C (1911) Part 2. Ixodidae. Section 1 classification. Section 2 the genus *Ixodes*. In: Nuttall et al (eds) *Ticks. A monograph of the Ixodoidea*. Cambridge University Press, Cambridge, pp i–xix, 105–348
- Nuttall GHF, Warburton C (1915) Part 3. The genus *Haemaphysalis*. In: Nuttall et al (eds) *Ticks. A monograph of the Ixodoidea*. Cambridge University Press, Cambridge, pp i–xiii, 349–550
- Parola P, Cornet JP, Sanogo YO, Miller RS, Thien HV, Gonzalez JP, Raoult D, Telford SR III, Wongsrichanalai C (2003) Detection of *Ehrlichia* spp., *Anaplasma* spp. *Rickettsia* spp., and other eubacteria in ticks from the Thai–Myanmar border and Vietnam. *J Clin Microbiol* 41:1600–1608
- Petney TN (1993) A preliminary study of the significance of ticks and tick-borne diseases in South-east Asia. *Mitt Österr Ges Tropenmed Parasitol* 15:33–42
- Petney TN, Keirans JE (1994) Ticks of the genus *Ixodes* in South-east Asia. *Trop Biomed* 11:123–134
- Petney TN, Keirans JE (1995) Ticks of the genera *Amblyomma* and *Hyalomma* in South-east Asia. *Trop Biomed* 12:45–56
- Petney TN, Keirans JE (1996) Ticks of the genera *Boophilus*, *Dermacentor*, *Nosomma* and *Rhipicephalus* (Acari: Ixodidae) in South-east Asia. *Trop Biomed* 13:73–84
- Petney TN, Keirans JE (1997) Ticks of the genus *Aponomma* in South-east Asia. *Trop Biomed* 13:167–172
- Phan TC (1977) Ve bet trung ky sinh Viet Nam. Tap Ve (Ixodoidea). Mo phan loi. Hanoi (in Vietnamese)
- Robbins RG, Platt SG (2000) First report of *Amblyomma clypeolatum* Neumann (Acari: Ixodida: Ixodidae) from the Union of Myanmar, with two new records from tortoises. *Proc Entomol Soc Wash* 102:225–226
- Robbins RG, Karesh WB, Rosenberg S, Schonwalter N, Inthavong C (1997) Two noteworthy collections of ticks (Acari: Ixodida: Ixodidae) from endangered carnivores in the Lao People's Democratic Republic. *Entomol News* 108:60–62
- Robbins RG, Platt SG, Keirans JE (2002) First report of *Hyalomma marginatum isaaci* Sharif (Acari: Ixodida: Ixodidae) from the Union of Myanmar, with a concurrent collection of *H. hussaini* Sharif. *Proc Entomol Soc Wash* 104:1061–1063
- Robbins RG, Bangs MJ, Keirans JE (2004) First report of *Ixodes kopsteini* Oudemans (Acari: Ixodida: Ixodidae) from the Kingdom of Cambodia, with a summary of known hosts of this tick in continental Southeastern Asia. *Proc Entomol Soc Wash* 106:472–474
- Robbins RG, Phong BD, McCormack T, Behler JL, Zwartepoorte HA, Hendrie DB, Calle PP (2006) Four new host records for *Amblyomma geoemydae* (Cantor) (Acari: Ixodida: Ixodidae) from captive tortoises and freshwater turtles (Reptilia: Testudines) in the Turtle Conservation Center, Cuc Phuong National Park, Vietnam. *Proc Entomol Soc Wash* 108:726–729
- Robinson LE (1926) Ticks. A monograph of the Ixodoidea. Part IV. The genus *Amblyomma*. Cambridge University Press, Cambridge
- Sarataphan N, Nilwarangkoon S, Tananyutthawongse C, Kakuda T, Onuma M, Chansiri K (1999) Genetic diversity of major piroplasm surface protein genes and their allelic variants of *Theileria* parasites in Thai cattle. *J Vet Med Sci* 61:991–994
- Schulze P (1930) Über einige Verwandte von *Ixodes ricinus* L. aus Ostasien. *Zool Anz* 90:294–303

- Schulze P (1933) Ixodidae der deutschen limnologischen Sunda-Expedition. Arch Hydrobiol Suppl XII Tropische Binnengewässer 4:490–503
- Schulze P (1934a) Über eine Zeckenausbeute von Kleinsäugetern aus Java. Z Parasitenk 7:167–171
- Schulze P (1934b) Die Arten der Zeckengattung *Dermacentor* s.l. aus Europa, Asien und Neu-Guinea. Z Parasitenk 6:416–431
- Schulze, P (1937). Die erste Zecke von einer Salangane, *Ixodes colloclaliae* n. sp. von Neupommern. Ornithol Monatsber (Berlin) 45:77–80
- Schulze P (1939) Zur Zeckenfauna Burmas. Z Parasitenk 10:722–728
- Smith CEG (1956) A virus resembling spring–summer encephalitis virus from an ixodid tick in Malaya. Nature 178:77–80
- Suksawat J, Yu XJ, Hancock SI, Hegarty BC, Nilkumhang P, Breitschwerdt EB (2001) Serologic and molecular evidence of coinfection with multiple vector-borne pathogens in dogs from Thailand. J Vet Intern Med 15:453–462
- Tanskul P, Inlao I (1989) Keys to the adult ticks of *Haemaphysalis* Koch, 1844, in Thailand with notes on changes in taxonomy (Acari: Ixodoidea: Ixodidae). J Med Entomol 26:537–601
- Tanskul P, Stark HE, Inlao I (1983) A checklist of the ticks of Thailand (Acari: Metastigmata: Ixodoidea). J Med Entomol 20:330–341
- Tay ST, Rohani MY, Ho TM, Devi S (2002) Isolation and PCR detection of rickettsiae from clinical and rodent samples in Malaysia. Southeast Asian J Trop Med Public Health 33:772–779
- Toumanoff C (1944) Les tiques (Ixodoidea) de l'Indochine. Saigon
- Walker JB, Keirans JE, Horak IG (2000) The genus *Rhipicephalus* (Acari, Ixodidae): a guide to the brown ticks of the world. Cambridge University Press, Cambridge
- Wassef H, Hoogstraal H (1983) *Dermacentor (Indocentor) compactus* (Acari: Ixodoidea: Ixodidae): identity of male and female. J Med Entomol 20:648–652
- Wassef H, Hoogstraal H (1984a) *Dermacentor (Indocentor) auratus* (Acari: Ixodoidea: Ixodidae): identity of male and female. J Med Entomol 21:169–173
- Wassef H, Hoogstraal H (1984b) *Dermacentor (Indocentor) atrosignatus* (Acari: Ixodoidea: Ixodidae): identity of male and female. J Med Entomol 21:586–591
- Wassef H, Hoogstraal H (1986a) *Dermacentor (Indocentor) taiwanensis* (Acari: Ixodoidea: Ixodidae): identity of male and female. J Med Entomol 23:173–177
- Wassef H, Hoogstraal H (1986b) *Dermacentor (Indocentor) steini* (Acari: Ixodoidea: Ixodidae): identity of male and female. J Med Entomol 23:532–537
- Wen B, Jian R, Zhang Y, Chen R (2002) Simultaneous detection of *Anaplasma marginale* and a new *Ehrlichia* species closely related to *Ehrlichia chaffeensis* by sequence analyses of 16S ribosomal DNA in *Boophilus microplus* ticks in Tibet. J Clin Microbiol 40:3286–3290